

AMIDOSTOMATINAE (NEMATODA: TRICHOSTRONGYLOIDEA) FROM AUSTRALIAN MARSUPIALS AND MONOTREMES

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Summary

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This work is a revision of the genera *Austrostrongylus* Chandler and *Nicollina* Baylis. Two new genera are proposed, *Paraustrostrongylus* and *Woolleya*; these four genera, with *Patricialina* Inglis, belong to the Amidostomatinae. *Filarinema* Mönnig is transferred to the subfamily Mackerrostrongylinae. *Austrostrongylus* and *Paraustrostrongylus* spp. are recorded from a phalanger and from macropod marsupials, *Nicollina* from monotremes and the numbat (a dasyurid), and *Woolleya* from dasyurids and a native eutherian, the water rat.

New species described are *Austrostrongylus hypsiprymmodontis* from *Hypsiprymmodon mōschatus*; *A. paratypicus* from *Macropus rufogriseus*; *A. chandleri* from *Macropus bicolor* and *M. rufogriseus*; *Paraustrostrongylus bettongia* from *Bettongia cuniculus*; *P. trichosuri* from *Trichosurus vulpecula*; *Nicollina calabyi* and *N. inglisi* from *Myrmecobius fasciatus*; *Woolleya sprenii* from *Dasyurus viverrinus*, *Antechinus stuartii*, *Dasyurops maculatus* and *Thylacinus cynocephalus*; *W. hickmani* and *W. monodelphis* from *Antechinus stuartii*; *W. martini* from *Antechinomys spenceri*.

Species redescribed in whole or in part are *Austrostrongylus macropodis* Chandler, *A. wallabiae* Johnston & Mawson, *A. aggregatus* Johnston & Mawson, *A. minutus* Johnston & Mawson, *A. thylogale* Johnston & Mawson, *Paraustrostrongylus potoroō* (Johnston & Mawson) (syn. *A. potoroō*), and *Nicollina echidnae* Baylis.

Other new combinations are *Woolleya sarcophilii* (Cameron), *W. cathiae* (Inglis), *W. iota* (Mawson), *W. acinocerus* (Mawson), all transferred from *Nicollina*, and *W. hydromyos* (Mawson), transferred from *Austrostrongylus*.

Introduction

The trichostrongyloid nematodes from Australian vertebrates were discussed by Inglis (1966) who considered that all belong to the family Amidostomatidae. In the subfamily Amidostomatinae he included (from marsupials) the general *Filarinema* Mönnig, *Patricialina* Inglis, *Austrostrongylus* Chandler and *Nicollina* Baylis. *Filarinema*, however, differs markedly from all other genera of the subfamily in the virtual absence of a buccal capsule—the teeth occur in an enlargement of the anterior end of the oesophagus, so this genus should be referred to the subfamily Mackerrostrongylinae Inglis, in which a buccal capsule is absent. Of the three genera from monotremes and marsupials remaining in Amidostomatinae, no *Patricialina* sp. has been found during the present study.

Up to the present, most of the species from marsupials have been identified as belonging to either *Austrostrongylus* (type species *A. macropodis* Chandler, 1924) or *Nicollina* Baylis, 1931 (type species *N. tachyglossae* Baylis, 1930). Proposing the genus *Nicollia* (which he changed to *Nicollina* in 1931) Baylis stated that this genus differs from *Austrostrongylus* in the presence of a shallower buccal capsule, the symmetrical bursa, the absence of ventral teeth, and in the shape of the tail of the female. More species were later attributed to each genus, and Mawson (1960, p. 264) pointed out that among species with ventral teeth, the female tail in some is conical and in others bears a terminal spine, and it was suggested that the best character on which to separate the genera would be the shape of the spicules, which in *Austrostrongylus* spp. are

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entire and in *Nicollina* spp. are bifid or trifid distally. Inglis (1968, p. 336) agreed with this and gave an amended list of species belonging to each genus.

In the present study, 13 new species of amidostomes have been identified from monotremes and from a variety of Australian marsupials, including dasyurids, from which only one species had previously been described (*N. calhiae* Inglis, 1968). The identification of these has entailed the re-examination of all available paratype or holotype specimens of existing species, and a re-evaluation of the generic characters.

Discussion

Two new genera are proposed, *Paraustrostrongylus* and *Woolleya*. Both *Paraustrostrongylus* spp. and *Austrostrongylus* spp. are characterised by wide and thick lateral alae and single-tipped spicules, and these features distinguish them from *Nicollina* spp. and *Woolleya* spp. in which lateral alae if present are small and thin and the spicule tips are divided. Distinct differences in the form of the buccal capsule and dorsal tooth distinguish *Nicollina* spp. from *Woolleya* spp. These four genera are found in different hosts, *Austrostrongylus* spp. and *Paraustrostrongylus* spp. being recorded from macropods and phalangers (herbivores), *Nicollina* spp. from the echidna and the numbat (termite and ant-eaters) and the platypus (which eats worms, etc.) and *Woolleya* spp. from dasyurids, bandicoots, and a eutherian, the water rat (all carnivores).

However, there are some species which are not satisfactorily accounted for. The spicules of *N. cameroni* (Mawson), *W. sarcophili* (Cameron) and *W. acinocercus* (Mawson) are not divided, but the body lacks the lateral alae and the characteristic bursa of *Austrostrongylus* and *Paraustrostrongylus*. In *Woolleya monodelphis* n.sp. and *W. hydromyos* (Mawson) the spicules are divided and the longitudinal crests are like those of *Woolleya* spp., but the tail of the female is pointed and lacks a spine. The position of these species will be discussed under *Woolleya* n.g.

The characters of the four genera will be described in detail below, but some general remarks are made here about the cuticular swellings and crests commonly found in species of all these genera. Cuticular ridges and cuticular inflations in the Heligmosomatidae have been studied in detail by Durette-Desset (1964, 1966) in species from the Old and New Worlds. According to this author almost all the

heligmosomes are rolled into a sinistral spiral. Some live coiled around villi (with the anterior end towards the base of the villus) and maintain their position by a combination of pinching with the internal (best developed) crests and the apposition of lateral crests and alae. Others, in which different areas of the body bear the best-developed crests, also form a sinistral coil, but not around a villus, and these move through the mucus between the villi with a corkscrew action, so that the outside of the coil (the dorsal body surface) which bears the best-developed crests, comes in contact with the villi.

Although they belong to a different group from the Heligmosomatidae, the Australian amidostomes may be compared with them in some respects. If they are coiled, it is in a sinistral spiral. In some genera (*Austrostrongylus* and *Paraustrostrongylus*) the lateral alae are very well developed, not only out from the body in a lateral direction, but they are almost as thick, dorsoventrally, as the body (Figs. 7, 13, 26). The cuticle over these enlarged alae bears one or more longitudinal ridges, and there are also one or more crests on the ventral surface of the body proper. These alae differ from those described by Durette-Desset as enlarged crests, because the enlargement is caused by subcuticular swelling, the crests themselves being of normal size (as indicated by their cuticular "skeleton") and merely borne on the inflated cuticle. In other genera, *Nicollina* and *Woolleya*, lateral alae are less distinct, and the longitudinal crests are variously distributed. In all cases males and females of the same species show similar peculiarities of structure and distribution of the crests. In some species, but by no means in all, there is a gradient around the body in the size of the crests. In many Australian species, crests are absent on the dorsal surface. An attempt has been made to classify the various species according to alae and crests. Those with two, wide, thick lateral alae form a natural group (also distinguished by other characters) which is further differentiated into the two genera *Austrostrongylus* and *Paraustrostrongylus*. Among the remaining species, in which lateral alae if present are of a different type, longitudinal crests are variously arranged—they may be many (8–20 or more) and distributed all round the body, or they may be few (2–4) and restricted to the ventral surface. However, neither of these types is associated with any one of the types of spicule tips, dorsal ray or female

tail, so that further classification on the type of crests is impracticable.

Most of the specimens examined were not seen *in situ* in the host, although a few were found coiled round torn off villi.

Unless otherwise indicated, all the transverse sections figured were taken about the midbody of the worm.

Measurements of new material are given in Tables 1, 2, 3, or 4, as indicated in each case under the species heading. Types of new species will be deposited in the South Australian Museum, Adelaide.

Key to genera

1. Lateral alae wide and thick; dorsal lobe of bursa markedly thickened 2
1. Lateral alae, if present, thin; dorsal lobe of bursa not thickened 3
2. Genital cone well developed, chitinised *Paraastrostrongylus*
2. Genital cone not well developed, not chitinised *Astrostrongylus*
3. Buccal capsule a shallow ring; dorsal tooth blunt, protrusible *Nicollina*
3. Buccal capsule domed anteriorly; dorsal tooth pointed *Woolleya*

AUSTROSTRONGYLUS Chandler

Amidostomatidae: Small usually coiled worms with thick and wide lateral alae; longitudinal cuticular crests on alae and on body proper; cephalic cuticle inflated; buccal capsule well developed, with one dorsal and sometimes two smaller subventral oesophageal teeth. Male: bursa more or less symmetrical, lateral lobes long, dorsal short and thick; dorsal ray usually dividing into three pairs of branches; externo-dorsal ray arising separately, other rays from same root, separating at tips; genital cone not distinct, spicules slender with simple points, sometimes united by small alae. Female: tail tapering to long point; vulva near posterior end of body, ovejectors divergent. Parasites of small intestine of macropod marsupials.

Type species: *A. macropodis* Chandler, 1924: 160.

Other species: *A. aggregatus* Johnston & Mawson, 1940b: 472; *A. minutus* Johnston & Mawson, 1938: 195; *A. thylogale* Johnston & Mawson, 1939: 534; *A. paratypicus* n.sp.; *A. chandleri* n.sp.; *A. hypsiprymnodon* n.sp.

In some species of *Astrostrongylus*, perhaps in all, there is a strong tendency to the deposition of a dark reticular and granular material under the cuticle. Durette-Dussel (1966, pp. 457, 461) notes a similar condition in some heligmosomes and, by staining, concluded that

it is a chitinous substance. This occurs especially in the lateral alae and in the bursa, and sometimes in the cephalic inflation, but may also appear in the older female between vulva and anus, all round the body. The distribution in the bursa appears to vary with the species; in many cases it obscures the dorsal ray, especially in long-stored specimens; it is resistant to clearing in lactophenol, but less so in creosote or Berlese's Fluid.

In all species of *Astrostrongylus* the dorsal lobe of the bursa, whether containing granular material or not, is much thickened, so much so that the lobe is in fact almost spherical, the inner or ventral face of the lobe extending to the cloaca. A genital cone, as such, is absent. Because of the shape of the bursa, the dorsal ray must be considered in three dimensions rather than two.

The characteristic bursa, and the striking strap-like form given to the body by the wide thick alae, appear to be important diagnostic features of the genus, although they have not previously been mentioned. Both characters are present in the type species of the genus, which is partially redescribed below.

***Astrostrongylus macropodis* Chandler, 1924:**
160. From Bennett's Kangaroo, *Macropus rufogriseus* var. *bennetti*.

FIGS. 1, 2

The type and paratype material of *A. macropodis* has been examined. The holotype male and cotype female (U.S.N.M. Helm. Coll. 26124) are on slides and impossible to examine thoroughly. What is assumed to be the paratype material is in the collection of the Department of Biology, Rice University. This material (H.N. 23049) is labelled 'from Bennett's Kangaroo' and was worked on by Dr. Chandler. The specimens agree closely in most particulars with Chandler's description of *A. macropodis*. They have the wide lateral alae and the swollen dorsal lobe of the bursa which have been seen in all other species of the genus. Unfortunately the darkening of the dorsal lobe obscures the final branching of the dorsal ray. It is clear, however, that the dark part of the dorsal lobe extends nearly to its posterior border, and that in Chandler's Fig. 3 the clear part of the lobe is its swollen inner surface, which is unpigmented, and which in some positions of the bursa appears to be its posterior border. Thus the dorsal ray extends nearly to the posterior edge of the bursa, and the dorsal lobe is shorter than indicated by Chandler. There may be two or three pairs of

branches of the dorsal ray, but the tips of the inner branches shown here in Fig. 1 are not clear. If there are only two pairs, this is the only species of the genus in which this is so. The tips of the spicules are enlarged by alae, as figured by Chandler.

The bodies of these specimens are so much contracted that a good transverse section could not be drawn. Allowing for some distortion, the sections made show alae and crests similar to those shown in Figs. 14 and 18, but with an extra crest on the dorsal aspect of the right side.

Key to species of *Austrostrongylus*

1. Female monodelphous *A. hypsiprymmodontis*
1. Female didelphous 2
2. Vagina long, more or less equal to distance from vulva to anus *A. aggregatus*
2. Vagina short 3
3. Spicules with relatively wide alae round tips 4
3. Spicules with small or no alae at tips 5
4. Male 4.5-5 mm long, spicules 375-500 μm *A. macropodis*
4. Male 3.8-4.7 mm long, spicules 520-700 μm *A. paratypicus*
5. Dorsal ray gives off first pair of branches, then bifurcates *A. minutus*
5. Dorsal ray gives off two pairs of branches, then bifurcates 6
6. Tips of spicules united in small ala 7
6. Tips of spicules not united in ala *A. wallabiae*
7. Three crests on each lateral ala; branches of dorsal ray elongate *A. thylagale*
7. One crest on each lateral ala; branches of dorsal ray short, stout *A. chandleri*

Austrostrongylus wallabiae Johnston & Mawson, 1939: 534, from *Macropus rufogriseus* (syn. *M. ruficollis*).

FIGS. 3-6; TABLE 1

Host and locality: *Macropus rufogriseus* from Logan Village, Qld.

New specimens as well as the type material have been examined and the original description can now be amended. As was stated, the type specimens are darkened by masses of granular material deposited under the cuticle in the wide, thick, lateral alae, in the bursa, especially in the dorsal lobe, and in the female at the posterior end of the body—in a few of the older specimens this region is so distended as to overhang the anus. In the newer specimens from Queensland there are similar dark masses but these are neither so thick nor so dark.

On the broad lateral alae there are longitudinal crests, three on one side, two on the other; there are also two large and one small ventral crests. There are no dorsal crests except those on the dorsal side of the alae (Fig. 1).

In the female the lateral alae terminate at about the level of the vulva, in the male the left ala reaches nearly to the bursa, and the right is rather shorter.

The buccal capsule is well developed with two small ventral, and one large dorsal, teeth.

The spicules are very slender, with simple acicular tips not enclosed in alae. The bursa is thick-walled, especially the dorsal lobe, and is more or less symmetrical—in some specimens the right lobe is rather longer and narrower than the left. The dorsal ray, seen more clearly in the new material, has one more pair of branches than originally described (Fig. 4).

The vulva in the original material is 500-600 μm from the posterior end of the worm (not 1,500 μm). The cuticle just in front of the vulva is more or less inflated (Fig. 2).

Although the species is similar to *A. macropodis*, there are distinct differences in the bursal rays, and there appears to be less granular material deposited in various parts of the body.

Austrostrongylus aggregatus Johnston & Mawson, 1940: 472, from *Wallabia bicolor* (syn. *Macropus wallabatus*).

FIGS. 7-10; TABLE 1

Host and locality: *Wallabia bicolor* from Logan Village, Qld.

The type male and female and the paratype material of this species have been re-examined and compared with the new material. Measurements of the new material are given in Table 1.

Two asymmetrical lateral alae are present, as well as three ventral longitudinal crests. The oesophagus widens gradually in its posterior third.

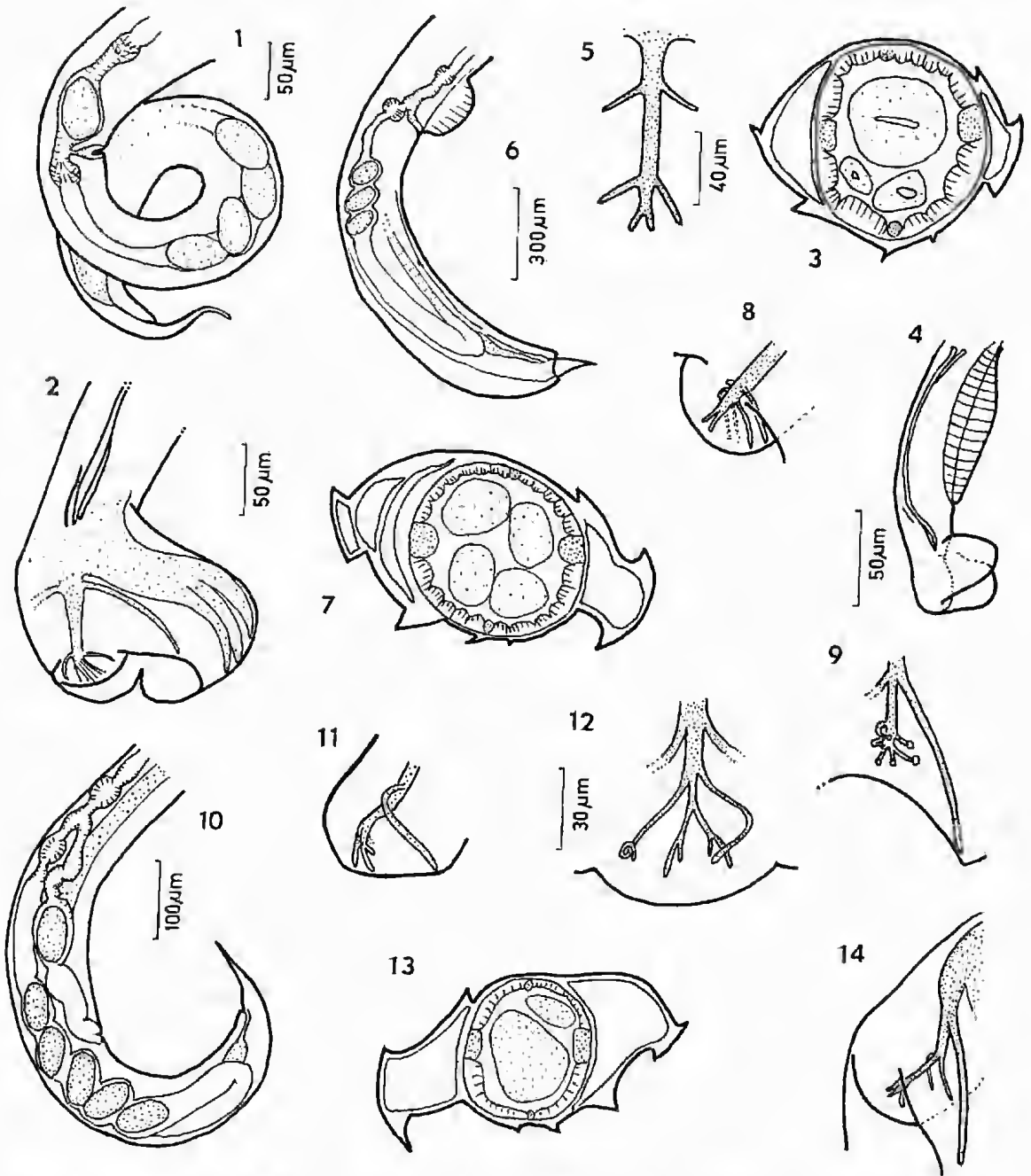
The vagina is unusually long, reaching a distance anterior to the vulva about equal to that of the vulva from the posterior end of the body.

The bursa is thick, particularly the dorsal lobe, and darkened with a granular deposit. In one male this deposit is almost absent, and the branches of the dorsal ray quite clear (Figs. 8, 9). The spicules are long and very slender, both ending in one ala. The gubernaculum is a thin plate.

Austrostrongylus minutus Johnston & Mawson, 1938: 195, from *Macropus dorsalis*.

FIGS. 11-12

The paratype material of this species has been examined; the lateral alae and the dorsal lobe of the bursa agree with the revised definition of these structures in *Austrostrongylus*. However, the few specimens have been greatly



Figs. 1-2. *Austrostrongylus macropodis*. Fig. 1.—Posterior end of female. Fig. 2.—Posterior end of male.
 Figs. 3-6. *Austrostrongylus wallabiae*. Fig. 3.—Transverse section of body of female. Fig. 4.—Posterior end of male. Fig. 5.—Dorsal ray. Fig. 6.—Posterior end of female.
 Figs. 7-10. *Austrostrongylus aggregatus*. Fig. 7.—Transverse section of body of male. Figs. 8 and 9.—Lateral and ventral views of dorsal ray. Fig. 10.—Posterior end of female.
 Figs. 11-12. *Austrostrongylus minutus*. Fig. 11.—Lateral view of dorsal lobe and dorsal ray. Fig. 12.—Ventral view of dorsal ray.
 Figs. 13, 14. *Austrostrongylus thylogale*. Fig. 13.—Transverse section of the body. Fig. 14.—Lateral view of dorsal lobe, with dorsal and one externo-dorsal rays.
 Figs. 3, 6, 7, 8, 11 and 13 to scale beside 6; Figs. 9, 12 and 14 to scale beside 12.

flattened and a useful transverse section cannot be given. There appears to be only one ventral body crest, apart from those on the alae. The lateral alae extend beyond the vulva in the female, and in the male the left ala is a little longer than the right. The right side of the bursa is rather longer than the left, but the rays are similar on the two sides. The dorsal lobe is so swollen as to be almost spherical, and the three pairs of branches of the dorsal ray (not two pairs) lie almost at right angles to its main axis.

Austrostrongylus thylogale Johnston & Mawson, 1940a: 99, from *Macropus eugenii* (syn. *Thylogale eugenii*), from Kangaroo I., S. Aust.; Mawson, 1959: 155, from *Setonix brachyura*, from Rottneest I., W. Aust.; Inglis, 1968: 336, from *S. brachyura*, W. Aust.

FIGS. 13-14

Specimens from the Kangaroo I. wallaby have been studied and compared with those of other species of *Austrostrongylus*. The lateral alae are broad and wide, asymmetrical in section, with three asymmetrical crests on the alae and two ventral crests on the body.

A. thylogale appears to be free from the granular deposits which obscure, or partially obscure, the bursa of some other species of the genus. The swollen dorsal lobe of the bursa is clear, and in it can be seen the three pairs of branches of the dorsal ray, penetrating the lobe in three planes (Fig. 14). In the female the lateral alae extend to just behind the vulva; in the male the left continues nearly to the bursa, the right ends shortly anterior to this. The spicule tips are united in a very small ala.

Austrostrongylus paratypicus n.sp.

FIGS. 15-18; TABLE 1

Host and locality: *Macropus rufogriseus* from the Bathurst district, N.S.W.

In the same host animal as specimens of *Austrostrongylus wallabiae*, there were about 20 specimens of a smaller and apparently new *Austrostrongylus* sp. The body form is similar to that of *A. wallabiae*, more or less tightly coiled. The lateral alae are very wide, with one crest on the left side and two on the right, and there are in addition two ventral crests. Towards the posterior end of the male the left ala terminates but the right, in most specimens dark with granular material, continues nearly to the bursa. In the female, the lateral alae extend to or a little beyond the vulva.

The buccal capsule is well developed, the dorsal tooth large and the two sub-ventral teeth

small. The nerve ring surrounds the oesophagus towards the end of the second third of its length. The excretory pore is close to, or behind, the base of the oesophagus in the male, rather more anterior in the female.

The tail of the female tapers to a long cylindrical process. Both ovejectors are well developed. A uterine egg near the ovejector is 90 x 45 μ m.

The bursa is thickened with granular material, especially in the dorsal lobe, where it often obscures the detail of the dorsal ray. The lateral lobes are asymmetrical, the left wider than the right. The three lateral and two ventral rays are closer together in the right lobe, diverging only near their tips. The external lateral ray of the left side is distinctly larger than that of the right. The dorsal ray gives off two branches before its final bifurcation, not all in the same plane (Fig. 18).

The spicules widen near their distal ends; the tips are alate, the alae are folded around the tips when lying in the body and when dissected out; in no case were the spicules extruded naturally. The gubernaculum is very small and thin.

The species is distinguished from *A. wallabiae* by the more posterior position of the vulva, the shape of the spicule tips, and the asymmetrical bursa. It seems to be close to *A. macropodis* (from the Tasmanian sub-species of *Macropus rufogriseus*). However, the spicules are longer. Because of this and the apparent difference in the branching of the dorsal ray, and also because the hosts come from widely different localities, the two species are regarded as separate.

Austrostrongylus chandleri n.sp.

FIGS. 19-24; TABLE 1

Hosts and localities: *Macropus rufogriseus* (type host) from *Wallabia bicolor* from Logan Village, Qld.

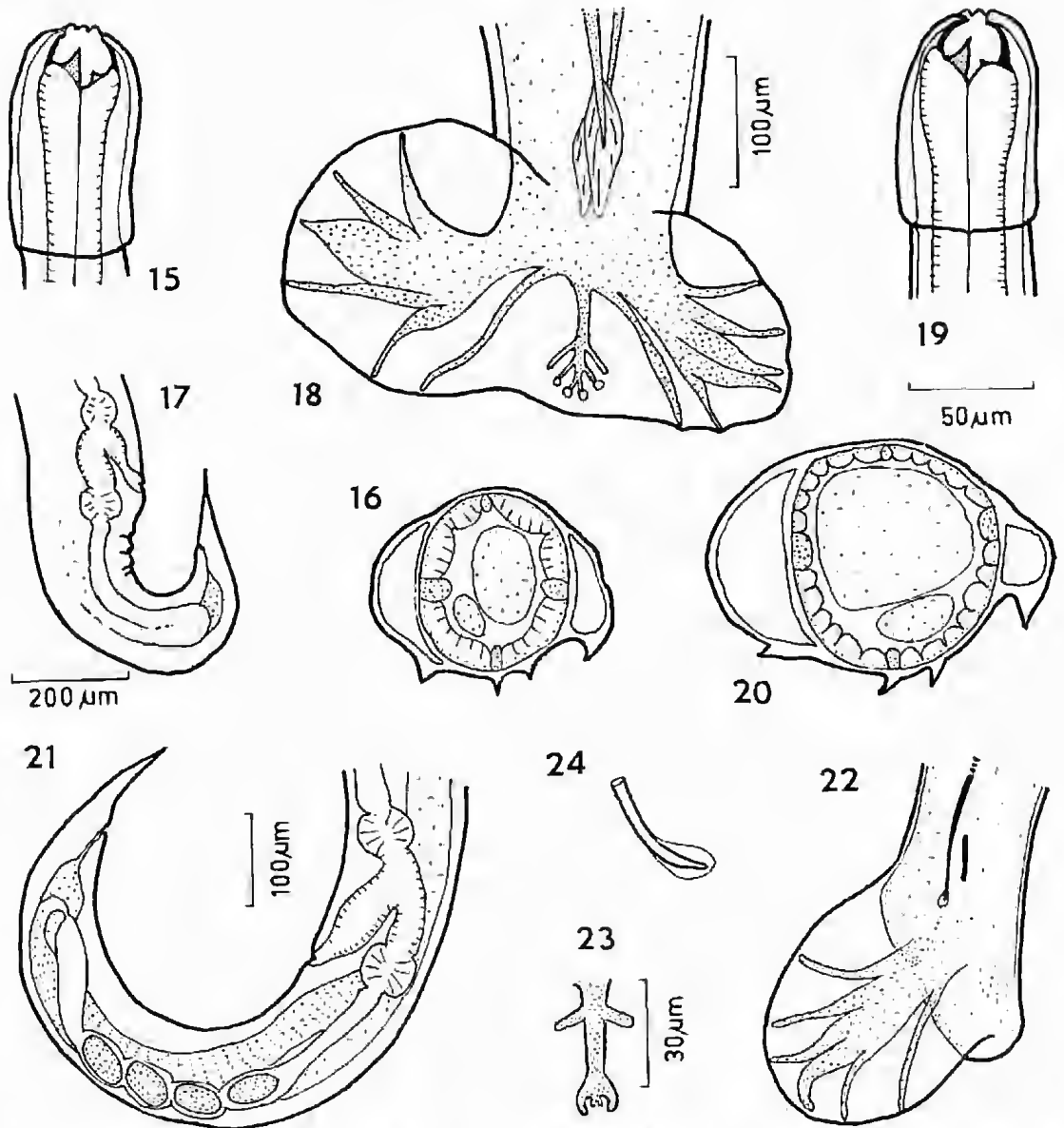
The body is loosely coiled. The lateral asymmetrical alae are well developed, each with one crest; in addition, two ventral crests are present. The buccal capsule is well developed, the dorsal tooth about half the depth of the capsule and the two sub-ventral teeth small.

The tail of the female tapers, ending in a thin finger-like piece. The vulva, well in front of the anus, leads to a short vagina; the ovejectors are about equal in size. The eggs are 75-85 x 45-50 μ m.

The spicules are long, slender throughout their length, and end in blunt tips slightly curved ventrally and enclosed in a single small

TABLE 1
Measurements of Austrostrongylus spp., taken from material newly recorded in this paper. Unless otherwise stated, measurements are in μm .

Species	<i>A. wallabiae</i>	<i>A. aggregatus</i>	<i>A. chandleri</i> (type host)	<i>A. paratypticus</i>	<i>A. hypsiprymmodonitis</i>
Male:					
Length (mm)	5.1-6.3	4.0-4.5	4.9-6.2	3.8-4.7	4.3-4.5
Oesophagus	420-550	330-420	400-480	330-450	280-310
Length/Oesophagus	9.3-13.9	9.7-12.1	10.4-14.1	10.2-14.2	14.5-15.3
Ceph. inflation	85-90	65-75	80-90	88-92	60-70
Antr. end—nerve ring	not clear	210 (1x)	220-245		140-145
—excr. pore	300-400	290-360	310-370		280-390
Spicules	600-730	840-1005	520-600	520-700	600-670
Length/spicule L.	8.2-9.0	4.3-4.7	8.8-10.5	6.5-8.2	6.4-7.2
Female:					
Length (mm)	7.8 (2x)	4.1-4.6	6.1-8.1	5.6-6.1	4.2-4.6
Oesophagus	500-670	300-400	420-490	410-460	315-370
Length/Oesophagus	11.5-15.6	11.5-13.7	13.2-16.6	13.2-14.1	11.9-14.4
Ceph. inflation	100 (2x)	70-80	75-85		63-75
Antr. end—nerve ring		200-220	220-270	230-250	165-210
—excr. pore		240-310	320-350	320-380	350-420
Tail	100-140	90-100	90-110	100-130	90-95
Postr. end—vulva	1100-1300	390-550	600-1100	600-800	190-200
Length/P—vulva	6.0-7.2	8.2-11.5	6.6-10.3	7.3-9.1	23.0-23.2
P—vulva/tail	9.3-11.0	4.3-5.5	6.7-10.6	6.0-6.4	2.0-2.2



Figs. 15-18. *Austrostrongylus paratypicus*. Fig. 15.—Head. Fig. 16.—Transverse section of body of male. Fig. 17.—Posterior end of female. Fig. 18.—Bursa of male.
 Figs. 19-24. *Austrostrongylus chandleri*. Fig. 19.—Head. Fig. 20.—Transverse section of body of male. Fig. 21.—Posterior end of female. Fig. 22.—Lateral view of bursa. Fig. 23.—Ventral view of dorsal ray. Fig. 24.—Tip of one spicule.
 Figs. 15, 19 and 20 to scale beside 18; Figs. 23 and 24 to scale beside 23.

oval ala. The gubernaculum is small and inconspicuous.

The bursa is more or less symmetrical, the dorsal lobe thick, the genital cone absent as such. The granular thickening of the bursa is strongly developed, darkening much of it, including the dorsal lobe and the area posterior and dorsal to the externo-dorsal rays.

The species resembles *A. wallabiae* in the arrangement of the bursal rays (Figs. 22, 23). It differs however in the distribution of the granular material in the bursa, in the absence of a lateral ala extending nearly to the bursa, and in the shape of the tips of the spicules. The form of the bursa and shape of the spicule tips are close to those of *A. thylogale*, but in

this species the bursa is without granular inclusions, the spicules are shorter, and the shape of the dorsal ray is different.

It will be seen from the measurements given in Table 1 that the specimens from *W. bicolor* are smaller than those from the type host. There is also some difference in the position of the longitudinal crests on the lateral alae in specimens from the two hosts, although this is similar in males and females for the same host, and in collections from the same host species. The value of this difference is uncertain; no other morphological difference can be seen between the specimens.

***Austrostrongylus hypsiprymmodontis* n.sp.**

FIGS. 25-29; TABLE 1

Host and locality: *Hypsiprymmodon moschatulus* from Qld.

This is a small coiled worm, with very well developed lateral alae, of which the right is wider than the left. There are five longitudinal crests, two on each lateral ala and one on the ventral surface of the body. In the female the right ala is a little shorter than the left, which widens considerably before ending at about the level of the vulva. In the male the two alae extend from just behind the cephalic inflation nearly to the bursa, where they end abruptly at the same level.

The buccal capsule is well developed. The dorsal tooth is about half the length of the capsule. The excretory pore lies well behind the oesophagus.

The bursa is symmetrical, the dorsal lobe short and swollen and with a vesiculate structure internally, which rather obscures the dorsal ray. The arrangement of the rays is shown in Figs. 28, 29. The spicules are long and slender and end in a point. The presence of terminal alae could not be determined. A small gubernaculum is present.

The tail of the female is about half the distance from vulva to posterior end of the body. Only one, the anterior, uterus and ovejector is present. Eggs are 63-65 x 35-37 μ m.

This species has been referred to *Austrostrongylus* because of the inconspicuous genital cone, the origin of the externo-dorsal ray, and the way the lateral alae in the male end at the same level just in front of the bursa. In these features it differs from *Paraustrostrongylus* spp. It is distinguished from other species of the genus by the monodelphous condition of the female and the posterior position of the vulva. The cuticular swelling around the vulva is of

the irregular form seen in other species of *Austrostrongylus* rather than the definite ventral outgrowth seen in *Paraustrostrongylus* spp.

PARAUSTROSTRONGYLUS n.g.

Amidostomatidae: Small, usually coiled, worms with thick, wide lateral alae; longitudinal crests present on alae and on rest of body; cephalic inflation present; ventral cuticle at posterior end of body inflated, forming prebursal, or pre-vulvar, swellings usually of distinctive shape. Buccal capsule small, with dorsal oesophageal tooth. Ventral teeth present or absent. Male: bursa of two lateral and one small dorsal lobes, thickened dorsally and usually ventrally; externo-dorsal ray arising from base of dorsal, dorsal dividing into three pairs of branches, ventro-ventral ray diverging markedly at its base from latero-ventral and lateral rays; genital cone strongly chitinised, spicules long and slender, ending together in one or two alae; gubernaculum small, plate-like; Female: tail tapering to long point; monodelphous, only anterior ovejector, uterus, and ovary developed. Parasites of the intestine of macropod marsupials.

Type species: *P. potoroo*, syn. *Austrostrongylus potoroo* Johnston & Mawson, 1949.

This genus is close to *Austrostrongylus* in the form of the lateral alae, the swollen dorsal lobe of the bursa, and the tapering tail of the female. It is distinguished from it by the presence of a well developed genital cone, divergent ventro-ventral rays in the bursa, and a prebursal cuticular inflation in the male, and by the absence of the posterior part of the reproductive system of the female.

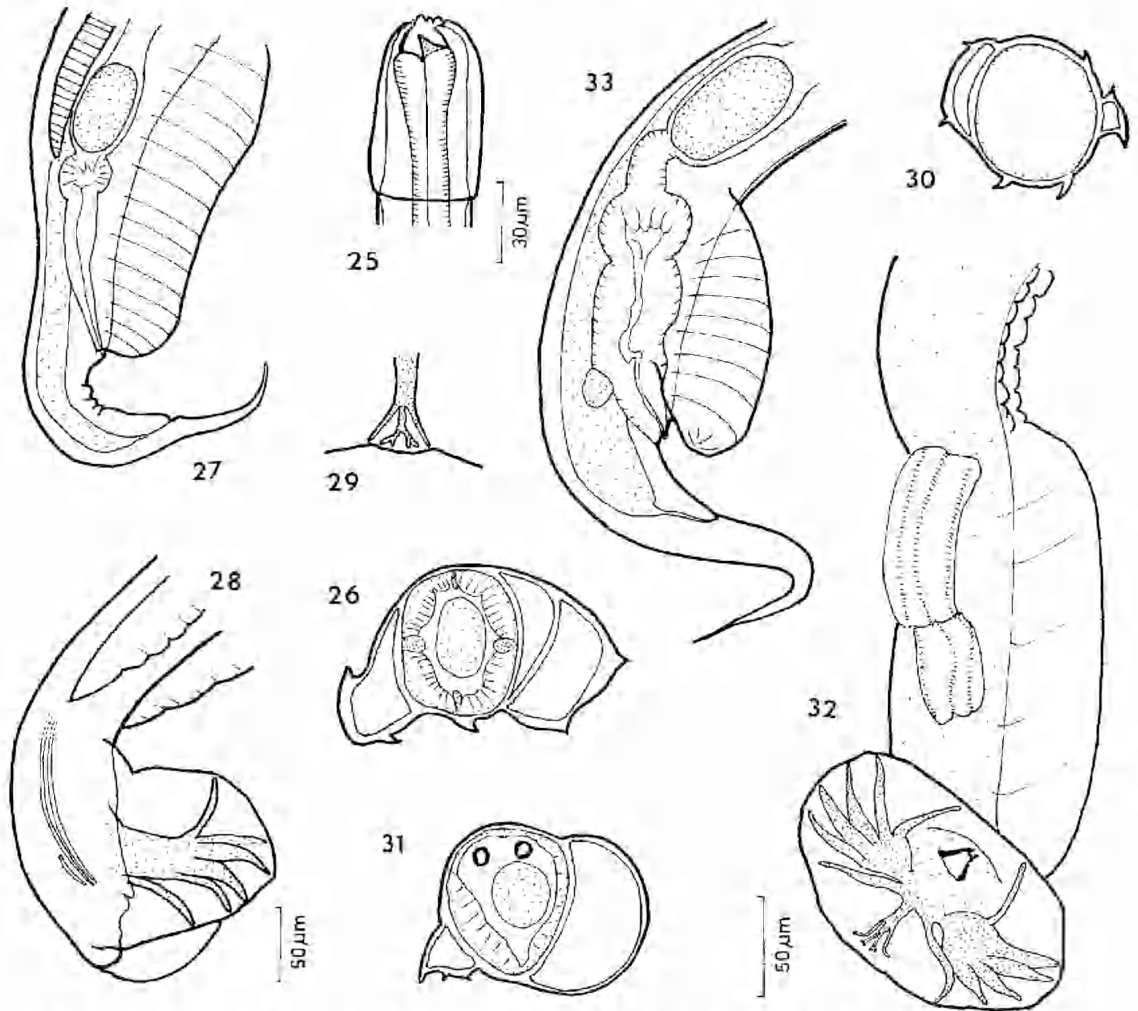
***Paraustrostrongylus potoroo* (Johnston & Mawson, 1969: 64), from *Potorous tridactylus*.**

FIGS. 30-33; TABLE 2

Host and locality: *Potorous tridactylus* from Hobart, Tas.

The type material of this species, as well as fresh material from the same host species, has been examined and a fuller description is now given.

The left lateral ala is thicker than the right; each bears two crests, and in addition there are two ventral cuticular crests and one dorso-lateral on the right side. These crests commence in the oesophageal region and continue to about the level of the vulva in the female and nearly to the bursa in the male. In the male the left ala becomes greatly inflated just an-



Figs. 25-29. *Austrostrongylus hypsiprymnodontis*. Fig. 25.—Head of female. Fig. 26.—Transverse section of body of male. Fig. 27.—Posterior end of female. Fig. 28.—Posterior end of male. Fig. 29.—Dorsal ray.
 Figs. 30-33. *Paraustrostrongylus potoroo*. Fig. 30.—Transverse section of body of male. Fig. 31.—Transverse section of male shortly in front of bursa. Fig. 32.—Posterior end of male. Fig. 33.—Posterior end of female.
 Figs. 26, 27 and 28 to scale beside 28; Figs. 29, 30, 31, 32 and 33 to scale beside 32.

terior to the bursa: the right ala ends a little anterior to this inflation. The subventral cuticle on the right side anterior to the bursa is raised into an elongate "blister" on which there are three obliquely longitudinal crests (Fig. 31).

The buccal capsule is small and the dorsal tooth relatively large. The ventral teeth are very small. The nerve ring lies just behind the mid-length of the oesophagus and the excretory pore is near its base.

The tail of the female tapers to a long point. The cuticle anterior to the vulva is greatly enlarged, forming a rounded mass overhanging

the vulva. The shape of this mass is similar on all new specimens examined, from two hosts, but in the older specimens it is flattened. Only the anterior part of the female reproductive system is present.

The bursa is slightly asymmetrical, with the left side, and its rays, a little larger than the right. The thickening of the dorsal lobe is not very marked. The arrangement of the bursal rays is shown in Fig. 32. The spicules are simple, undivided at the tips. A small gubernaculum is present. The genital cone is strongly chitinised, and probably acts as an accessory guide for the spicule.

TABLE 2

Measurements of *Paraastrostrongylus* spp. Unless otherwise indicated, measurements are in μm :

	<i>P. potoroo</i>	<i>P. bettongia</i>	<i>P. trichosuri</i>
Male:			
Length (mm)	2.4-2.6	4.0-4.4	4.3-5.3
Oesophagus	240-275	340-380	350-420
Ceph. inflation	40-48	70-80	90-100
Antr. end—nerve ring	120-150	218-230	250-270
—excr. pore	210-230	330-400	460-510
Spicules	250-260	380-400	380-450
Gubernaculum	40-45	45-50	35-40
Female:			
Length (mm)	2.7-3.0	5.7-6.0	5.0-6.7
Oesophagus	250-290	340-410	400-435
Ceph. inflation	45-50	80-85	80-100
Antr. end—nerve ring	130-140	200-220	230-260
—excr. pore	200-250	280-340	440-510
Tail	90-120	105-140	120-150
Postr. end—vulva	150-200	310-370	250-330

Paraastrostrongylus bettongia n.sp.

FIGS. 34-41; TABLE 2

Host and locality: *Bettongia gaimardi* from Tas.

These are relatively large worms lying in tight or loose coils. There are two longitudinal crests on each lateral ala and two additional ventral crests. Each of these ends a little in front of the vulva in the female. Shortly in front of the bursa of the male, the right ala disappears but the left is much enlarged. Between the termination of the right ala and the bursa there is an elongate subventral inflation bearing 3 to 4 oblique-longitudinal crests (Fig. 38).

In nearly every specimen the anterior end is curved back against the rest of the body. The cephalic inflation is about a fifth of the length of the oesophagus. The buccal capsule is shallow, the dorsal tooth short. The nerve ring is at about the middle, and the excretory pore near the posterior end of the oesophagus.

All three lobes of the bursa are thickened. Ventral to the chitinised genital cone there is a cuticular thickening, which merges at each side with the ventral part of the bursa, and which is penetrated by the ventro-ventral ray. The arrangement of the bursal rays is shown in Figs. 39-41. Because of the thickening of the dorsal lobe, the branches of the dorsal ray are not all in the same plane. The spicules end in alae, folded around the tips. The short gubernaculum is finely bossed.

The vulva is about three tail lengths from the posterior end of the body. Anterior to the vulva the ventral cuticle is greatly inflated, and hangs over the vulva in an elongate sausage

shaped mass. The shape of this mass is similar in all specimens from the two host animals. No vestige was seen of the posterior part of the female reproductive system. Eggs are 54-55 x 32-33 μm .

The species is distinguished from *P. potoroo* by the form of the bursa, which is not asymmetrical and is thicker-walled, by the size of the ventral tooth, the distance of the vulva from the anus, and the shape of the vulvar flap.

Paraastrostrongylus trichosuri n.sp.

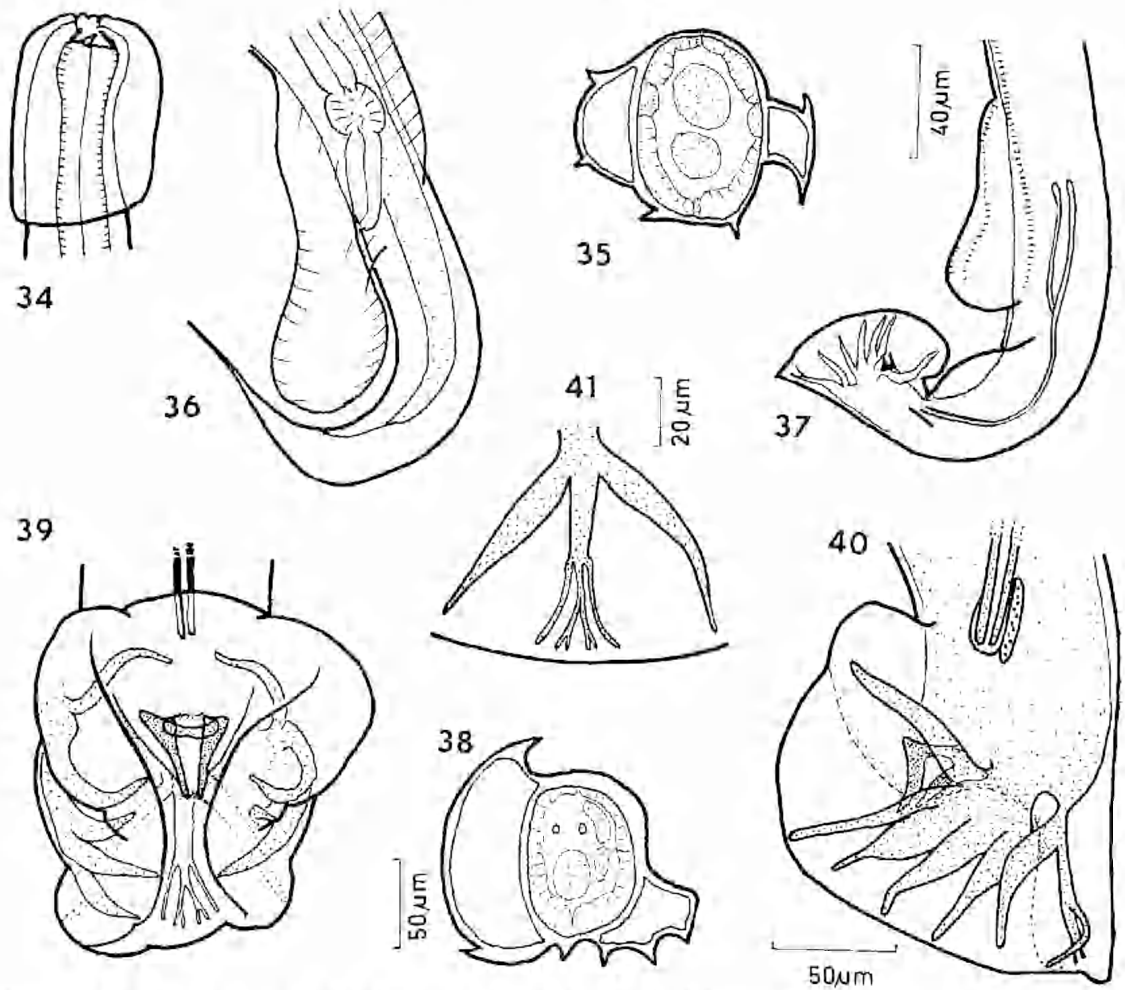
FIGS. 42-47; TABLE 2

Host and locality: *Trichosurus vulpecula* from D'Aiguillar and Camp Mt., Qld.

These worms are coiled into a fairly tight spiral from which the anterior and posterior ends protrude. The lateral alae are well developed, the right with three longitudinal crests and the left with two, and there are also three ventral longitudinal crests. In the male the crests and right ala disappear a short distance in front of the bursa and are replaced by a sub-ventral inflation. The left ala is wider in this region and terminates close to the bursa. In the female the alae and crests are discontinued just in front of the vulva and there is a separate small ventral inflation just anterior to the vulva.

The cephalic inflation is about a fifth of the length of the oesophagus. The buccal capsule is shallow, and the dorsal tooth small; sub-ventral teeth are apparently absent.

In the female the tail tapers to a fine point; the vulva is about a tail length in front of the anus. Eggs are about 70 x 45 μm .



Figs. 34-41. *Paraastrostrongylus bettongia*. Fig. 34.—Head of female. Fig. 35.—Transverse section of body of male. Fig. 36.—Posterior end of female. Fig. 37.—Posterior end of male. Fig. 38.—Transverse section of body through prebursal inflation. Fig. 39.—Ventral view of bursa, without coverslip. Fig. 40.—Lateral view of bursa. Fig. 41.—Dorsal and externo-dorsal rays.

Figs. 34, 35, 39, and 40 to scale beside 40; Figs. 36 and 37 to scale beside 37.

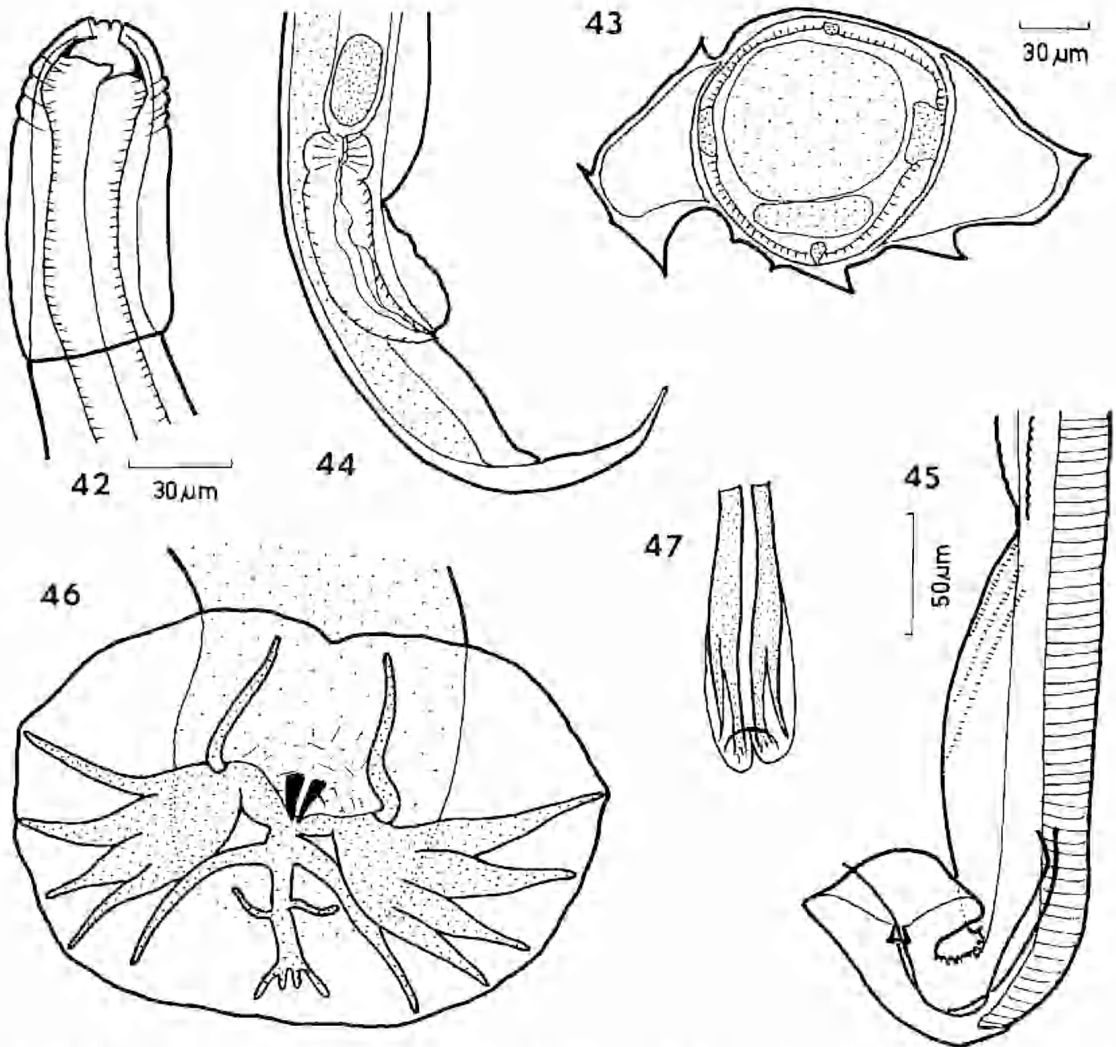
The margin of the bursa is entire, and the dorsal and ventral parts are swollen. The genital cone is strongly cuticularised. The arrangement of the rays is shown in Fig. 46. The dorsal ray however is partially obscured in all specimens examined by refractive inclusions in the bursal wall close to the mid-dorsal line; the ray is small, as it must be restricted to the region of the inclusions.

The species differs from both *P. potaroo* and *P. bettongia* in the greater development of lateral alae in comparison with the body diameter, as well as in the dorsal ray and the smaller prevulvar swelling. The bursa itself is less swollen than that of *P. bettongia* and more so than that of *P. potaroo*.

NICOLLINA Baylis

Nicollina Baylis, 1930: 550, syn. *Nicollia Baylis*, 1930, nec Nuttall, 1908, nec Kritschewsky, 1922.

Amidostomatinae: body with longitudinal crests and sometimes with one or two lateral alae; anterior end with inflated cuticle; buccal capsule shallow, stoutly built, containing a blunt dorsal oesophageal tooth. Bursa more or less symmetrical, dorsal lobe absent or poorly developed; dorsal ray dividing into four branches; externo-dorsal ray arising separately or from base of dorsal ray; lateral and ventral rays somewhat divergent. Spicules usually bifurcate or trifurcate; gubernaculum present. Fe-



Figs. 42-47. *Paraastrostrongylus trichosuri*. Fig. 42.—Head of male. Fig. 43.—Transverse section of body of female. Fig. 44.—Posterior end of female. Fig. 45.—Posterior end of male. Fig. 46.—Bursa spread out, inside view. Fig. 47.—Tips of spicules. Figs. 43 and 46 to same scale, 44 and 45 to same scale, 42 and 47 to same scale.

male didelphous, vulva towards posterior end of body; tail of female with dorsal terminal spike and two short subventral terminal lobes. Parasites of monotremes and Australian marsupials.

Type species: *N. tachyglossae* (Baylis).

Other species: *N. echidnae* (Baylis, 1930); *N. ridei* Inglis, 1969; *N. cameroni* Mawson, 1959; *N. calabyi* n.sp.; *N. inglisi* n.sp.; *N. baylisi* n.sp.; *N. mundayi* n.sp.

Through the courtesy of Dr. W. G. Inglis and the British Museum (Natural History) it has been possible to examine the type specimens of *N. tachyglossae* and *N. echidnae*. In

comparing these with other species attributed to *Nicollina*, it appears that not enough consideration has been given to the shape of the buccal capsule and the dorsal tooth. In *N. tachyglossae* (Fig. 48) and *N. echidnae* the buccal capsule is shallow, ring-like, and stoutly built, and the dorsal tooth is blunt and apparently readily protruded through the mouth (Fig. 49). In some other species (*N. cathiae* Inglis and *N. sarcophili* Cameron) the buccal capsule is thinner, deeper, and somewhat domed, and the dorsal tooth is erect and pointed and does not seem ever to be protruded through the oral opening. Moreover, in *N. tachyglossae* and *N. echidnae* the tail of the

female ends in a dorsal spine and two sub-ventral processes. In species with a deeper buccal capsule this type of tail has not been seen.

It is concluded that species having these characteristics in common should be grouped in a genus for which the name *Nicollina* is available. For the other species formerly included in *Nicollina* a new genus, *Woolleya*, is proposed.

Key to species of *Nicollina*

- | | |
|--|------------------------|
| 1. Worms more or less coiled | 2 |
| 1. Worms not coiled | 5 |
| 2. Dorsal ray with three pairs of branches | 3 |
| 2. Dorsal ray with two pairs of branches | 4 |
| 3. Buccal ring thick, lobed anteriorly | <i>N. calabyi</i> |
| 3. Buccal ring not lobed, thinner and deeper | <i>N. inglisi</i> |
| 4. Spicules bifid | <i>N. ridei</i> |
| 4. Spicules simple | <i>N. cameroni</i> |
| 5. Spicules trifid | 6 |
| 5. Spicules bifid | 7 |
| 6. One lateral ala present | <i>N. echidnae</i> |
| 6. Lateral alae absent | <i>N. tachyglossae</i> |
| 7. Lateral alae present | <i>N. mundayi</i> |
| 7. Lateral alae absent | <i>N. baylisi</i> |

Nicollina echidnae Baylis

FIG. 50

Nicollina echidnae (Baylis) Baylis, 1931; Mawson, 1959: 154; syn. *Nicollina echidnae* Baylis, 1930: 14. From *Tachyglossus aculeatus*.

The material examined in 1959 from an echidna from Kangaroo I. has now been compared with the type material of the species, and the identification confirmed. A transverse section of the Kangaroo I. specimen is given. In this species, and in *N. tachyglossae*, the excretory pore, not mentioned by Baylis, is post-oesophageal.

Nicollina cameroni Thomas, 1959: 154, from the Echidna, *Tachyglossus aculeatus*.

FIGS. 51-52

The paratype material of this species has been re-examined. The body was described as having two lateral alae and "some appearance of longitudinal banding". Transverse sections show a very slight widening of the cuticle laterally and in addition about 16 crests, most of them lateral or ventral. The tooth is blunt, and lies for the most part in the oesophageal funnel.

This species differs from others of the genus in that the spicules are not divided distally, but in view of the similarity of other characters it has been retained in the genus. It differs very markedly from species of *Austrostrongylus* and

Paraustrostrongylus, in which the spicules are single, in characters of the lateral alae, buccal capsule, dorsal tooth, and bursa.

Nicollina baylisi n.sp.

FIGS. 53-59; TABLE 3

Host and locality: *Tachyglossus aculeatus*, Tas.

These are straight worms, with a cephalic inflation, followed by numerous very low longitudinal crests. Lateral alae are absent. The buccal capsule is very shallow. The oesophagus is more or less cylindrical in its anterior two-thirds then widens to an elongate bulb at the posterior end. The nerve ring surrounds it just behind its midlength and the excretory pore and cervical papillae are at about the same level near its posterior end.

The lateral lobes of the bursa are very long and are folded over each other. The externo-dorsal ray arises from the dorsal and diverges widely from it. The dorsal ray divides into two bifid branches near its distal end. The spicules are bifid for about half their length. The outer branch of each ends in a barb and bears about 10 well-marked transverse ridges in the middle third of its length. The end of each branch is surrounded by an ala, that on the smaller branch much wider than that on the larger. The gubernaculum is stout, pitted on the surface, and rather more than half the spicule in length.

The tail of the female is rounded and bears a subterminal spike and two small lobes. The vulva, a transverse slit in a depression of the body wall, lies at a little less than a sixth of the body length, or 20-27 tail lengths, from the posterior end of the body. Uteri are opposed. The eggs are 79-80 x 43-45 μ m.

The species is in many ways very like *N. tachyglossae*, a straight worm with 8-10 longitudinal crests and with somewhat similar, but trifid, spicules. The two species differ however in body length, position of the vulva, and size of the gubernaculum.

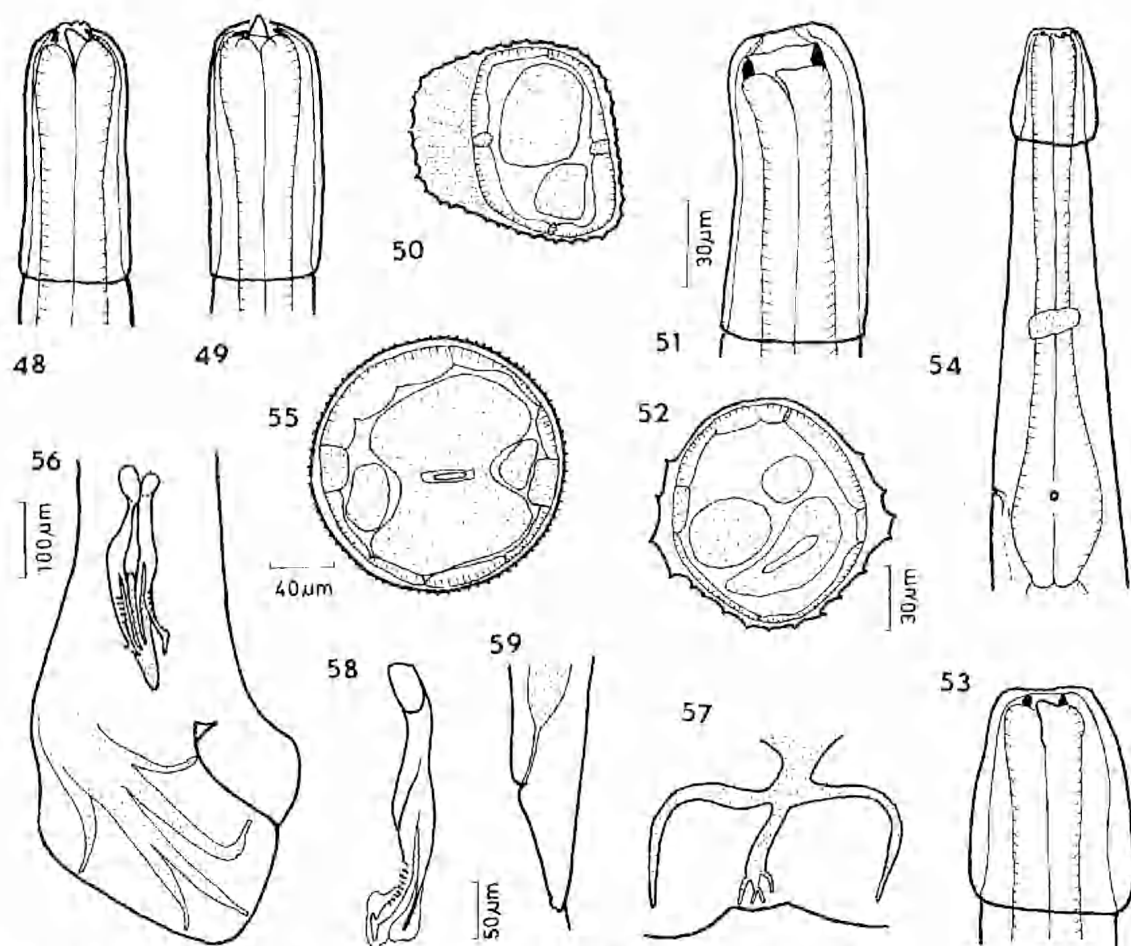
Nicollina mundayi n.sp.

FIGS. 60-66; TABLE 3

Host and locality: *Tachyglossus aculeatus* and *Ornithorhynchus anatinus* from Tas.

This is a short straight worm very similar in some respects to *N. echidnae*. There are two lateral alae and about 20-22 longitudinal cuticular crests, more or less evenly distributed around the body circumference for most of its length, but fewer towards the extremities.

The buccal capsule is short, ring-shaped; the dorsal tooth is blunt and, at rest, hardly pro-



Figs. 48, 49. *Nicollina tachyglossae*, lateral and dorsal views of anterior end.
 Fig. 50. *Nicollina echidnae*, transverse section of body.
 Figs. 51, 52. *Nicollina cameroni*. Fig. 51.—Head. Fig. 52.—Transverse section of body.
 Figs. 53–59. *Nicollina baylisi*. Fig. 53.—Oesophageal region. Fig. 54.—Lateral view of head. Fig. 55.—Transverse section of body just posterior to oesophagus. Fig. 56.—Posterior end of male. Fig. 57.—Dorsal ray. Fig. 58.—One spicule. Fig. 59.—Tail of female.
 Figs. 48, 49, and 51 to scale beside 51; Figs. 52 and 53 to same scale; Figs. 54, 57, 58, and 59 to scale beside 59.

jects into the buccal cavity. The oesophagus is cylindrical for most of its length, ending in a bulb. The nerve ring lies at about half, and the excretory pore and the small but distinct cervical papillae at three-quarters the length of the oesophagus.

The end of the tail of the female bears a terminal spike and two small subterminal lobes. The vulva, at about 8–11 tail lengths in front of the anus, lies between two rounded expansions of the lateral alae. Eggs are about $75 \times 40 \mu\text{m}$.

The spicules are bifid, the outer branch of each is longer and stouter than the other and ends in a barbed point, the inner branch ending

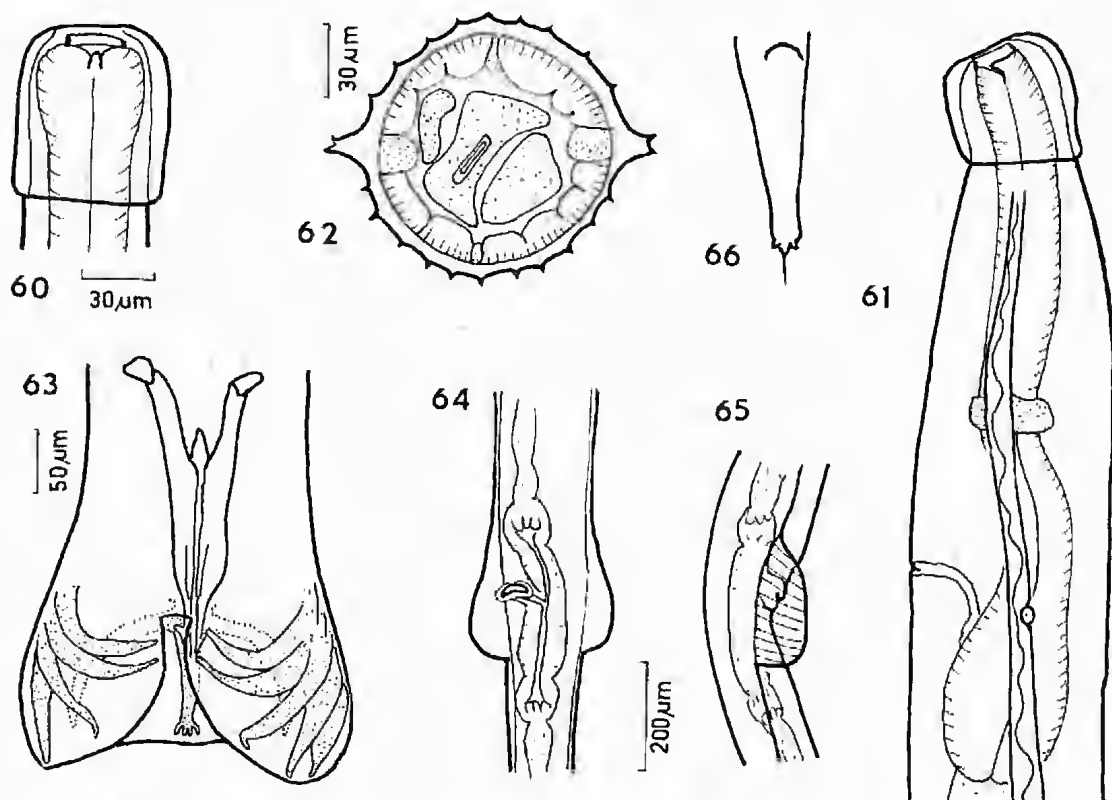
simply. As only two male worms are present, the spicules were not dissected out. Their appearance is very similar to those of *N. baylisi*, on which the terminal alae were not visible until the spicules were out of the body. The gubernaculum, at least two-thirds the length of the spicules, is strongly built and its surface pitted. The lateral lobes of the bursa are not particularly long. The rays are shown in Fig 63.

The species closely resembles *N. baylisi*, but is distinguished by being distinctly shorter, with lateral alae and with fewer and more prominent cuticular crests, as well as by the shape of the bursa, the absence of ridges on the spicules,

TABLE 3

Measurements of *Nicollina baylisi*, *N. mundayi*, *N. calabyi*, and *N. inglisi*. Unless otherwise indicated, measurements are in μm .

Species	<i>N. baylisi</i>	<i>N. mundayi</i>	<i>N. calabyi</i>	<i>N. inglisi</i>
Host	echidna	echidna	platypus	numbat
Male:				
Length (mm)	12.8-14.1	5.2, 5.3	4.6-5.7	2.4-3.4
Oesophagus	500-525	445, 500	400-450	330-360
Ceph. inflation	80 (3x)	75, 75	70-100	50-70
Antr. end—nerve ring	210-220	215, 220	220-230	120-170
—excr. pore	360-400	275, 315	370-390	160-260
Spicule	240-275	270, 295	250-270	600-700
Gubernaculum	145-165	140, 152	140-160	80-110
Female:				
Length (mm)	24.3, 25.3	6.5-8.1	7.7-8.0	2.5-4.2
Oesophagus	600, 520	480-510	450-500	260-400
Ceph. inflation	100, 110	75-80	80-110	60-80
Antr. end—nerve ring	300, 270	210-240	230-240	120-200
—excr. pore	500, 550	230-305	380-400	150-345
Tail	190, 150	120-140	140-165	70-130
Postr. end—vulva	3800, 4100	1250-1400	1500-1600	350-460



Figs. 60-66. *Nicollina mundayi*. Fig. 60.—Head. Fig. 61.—Oesophageal region. Fig. 62.—Transverse section of body. Fig. 63.—Posterior end of male, ventral view. Figs. 64 and 65.—Ventral and lateral views of region of vulva. Fig. 66.—Tail of female.
Figs. 61-66 to same scale; Figs. 64 and 65 to same scale.

and the presence of cuticular flaps beside the vulva. The measurements are similar to those of *N. echidnae*, but the two species are distinguished by the shape and size of the spicules and of the dorsal and externo-dorsal rays, and by the presence of the well-developed left lateral ala in *N. echidnae*.

***Nicollina calabyi* n.sp.**

FIGS. 67-72, TABLE 3

Host and locality: *Myrmecobius fasciatus* from W. Aust.

The body forms a loose coil. The length of the anterior cuticular inflation is about one and a half times the body width just behind the inflation, and about a fifth to a sixth the length of the oesophagus. The cuticle of the rest of the body is raised into 8-9 lateral and ventral longitudinal crests, of which the lateral are the best-developed.

The mouth is surrounded by six small cuticular lips. The buccal capsule is stoutly built, its anterior edge six-lobed, each lobe formed by a thickening of the wall on the outer side of the capsule. The dorsal tooth is rounded at the apex, and reaches to about half the depth of the buccal capsule. The oesophagus is wider in the second half of its length and is surrounded by the nerve ring at the end of its first quarter; the excretory pore lies at about the end of the third quarter.

The tail of the female is rounded at the tip, with a subterminal spine of low ventral prominence. The vulva is a transverse slit, three to four tail lengths in front of the anus. At the level of the vulva the cuticle is raised into three longitudinal crests, one, bilobed, to the left of the vulva, a frilled narrow one to the right of the vulva, and a longer wider one to the right of this again (Fig. 72). The sizes and arrangement of these crests are similar in all the specimens available. The eggs are thin-shelled, 65-70 x 35-40 μm .

The spicules of the male are bifid for the terminal 80-100 μm , the shorter of the two ends pointed, the longer truncated and slightly barbed. The gubernaculum is elongate, rounded at the ends, and thicker in the central parts. The bursa has a short dorsal lobe, slightly separated from the large latero-ventral lobes. The rays are arranged as shown in Fig. 69.

The species is placed in the genus *Nicollina* because of the form of the buccal capsule and tooth. It differs from the species from monotremes in the form of the dorsal ray, as well as

in the presence of 3 cuticular crests near the vulva.

***Nicollina inglisi* n.sp.**

FIGS. 73-76; TABLE 3

Host and locality: *Myrmecobius fasciatus* from W. Aust.

This is a rather slender loosely coiled worm. The length of the inflated cephalic cuticle is about twice the width of the body just behind it. There are 8-10 longitudinal crests on the body, two dorsal and two lateral, and the rest ventral. The buccal cavity contains a large blunt tooth. The oesophagus widens in its posterior third and the nerve ring surrounds it at about the end of the first third. The excretory pore is at the end of the second third.

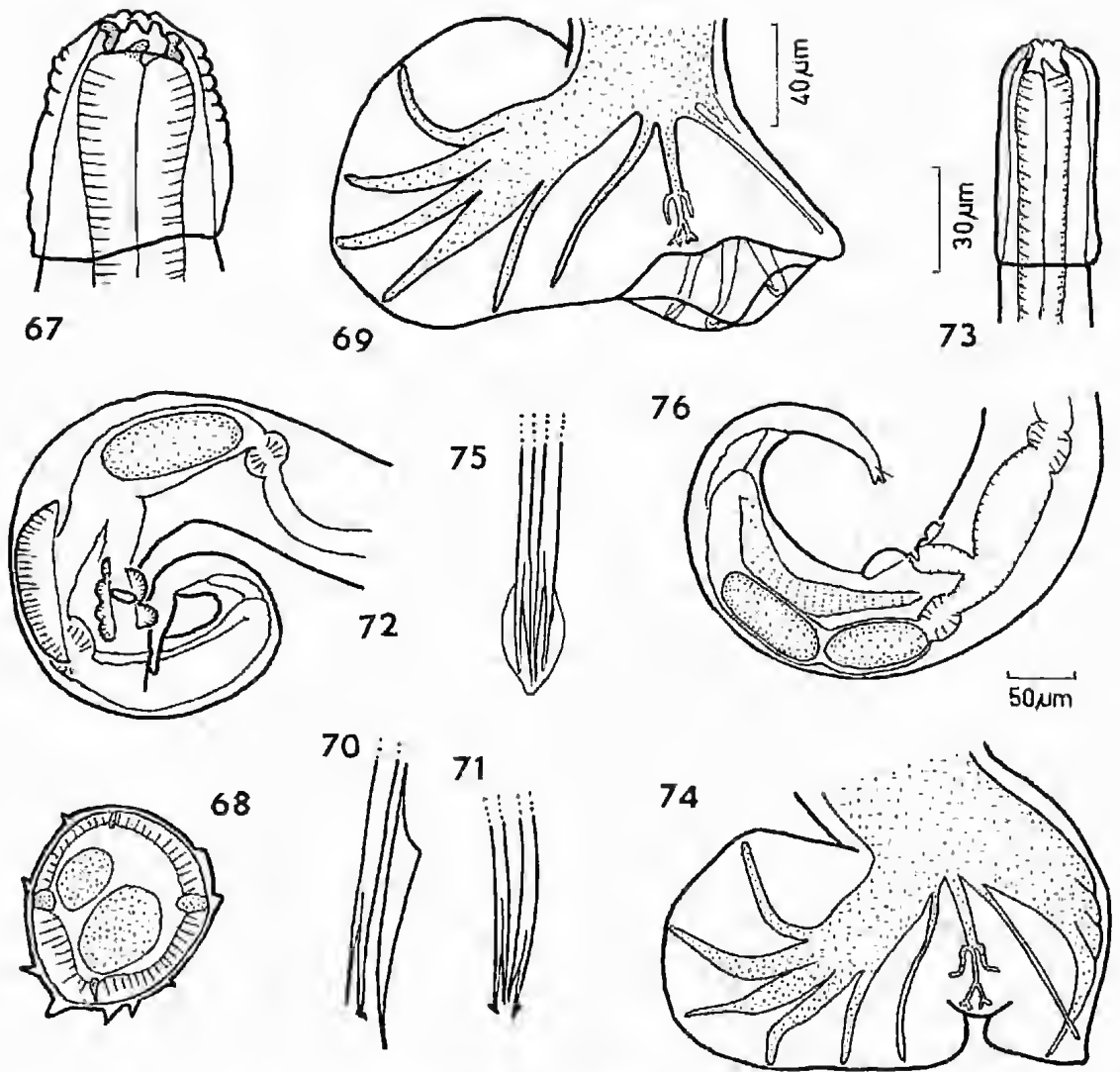
The tail of the female tapers to a bi-lobed tip, with a spike arising subterminally. The vulva is a transverse slit situated about three to four times the tail length in front of the anus. The cuticle just anterior and posterior to the vulva is slightly inflated and strongly striated. Amphidelphous, posterior uterus short, but containing developing eggs. Eggs are up to 100 x 50 μm .

In the male, one side of the bursa is slightly longer than the other, but the rays are similarly disposed. The dorsal lobe is short and the dorsal ray thin (Fig. 74). The spicules are bifid, with one branch shorter than the other, and the four tips, two from each spicule, appear to be enclosed in one terminal ala.

The species is close to *N. calabyi*, which was found in the same collections. It is distinguished by the more slender build of the body, the relatively longer cephalic inflation, the slightly thinner-walled and deeper buccal capsule, without anterior thickening; in addition, the gubernaculum is longer, and there is a small but consistent difference in the dorsal rays.

WOOLLEYA n.g.

Amidostomatinae: Small, more or less coiled worms with inflated cephalic cuticle and longitudinal cuticular crests behind this; buccal capsule well developed, with pointed dorsal tooth. Male: bursa more or less symmetrical, dorsal lobe small, dorsal ray dividing into two or three branches, externo-dorsal ray arising from dorsal ray or separately; lateral and ventral rays arising together, diverging from mid-lengths; genital cone not strongly developed, spicules single or divided at tips; gubernaculum well developed. Female: tip of tail rounded with thin spike, or tapering to a point; vulva



Figs. 67-72. *Nicollina calabyi*. Fig. 67.—Head. Fig. 68.—Transverse section of body. Fig. 69.—Bursa. Fig. 70. Gubernaculum and tips of one spicule, lateral view. Fig. 71.—Tips of both spicules, ventral view. Fig. 72.—Posterior end of female.
 Figs. 73-76. *Nicollina inglisi*. Fig. 73.—Anterior end. Fig. 74.—Bursa. Fig. 75.—Tips of spicules. Fig. 76.—Posterior end of female.
 Figs 67, 70, 71, 73, and 75 to scale beside 73; Figs. 68, 69 and 74 to scale beside 69; Figs. 72 and 76 to scale beside 76.

towards posterior end of worm; mono- or didelphous. Parasites of intestine of Australian mammals, mainly of marsupials.

Type species: *W. sprengi* n.sp.

Other species: *W. cathiae* (Inglis), syn. *Nicollina cathiae*; *W. sarcophili* (Cameron), syn. *Nicollina sarcophili*; *W. iota* (Mawson), syn. *Nicollina iota*; *W. acinocercus* (Mawson), syn. *Austrostrongylus acinocercus*; *W. hydromyos* (Thomas), syn. *A. hydromyos*;

W. hickmani n.sp.; *W. martini* n.sp., *W. monodelphis* n.sp.

The genus is named in recognition of the help given by Dr. Patricia Woolley in collecting specimens from dasyurids.

Woolleya species are distinguished from *Nicollina* spp. chiefly by the shape of the buccal capsule which is cup-like with relatively thin walls, and by the shape of the sharply pointed dorsal tooth, originating from the anterior end

of the oesophagus rather than, as in *Nicollina* spp., from the anterior end of the wall of the lumen of the oesophagus.

Figures are given of transverse sections of *W. acinocercus* and *W. hydromyos*, which have been re-examined but are not redescribed here (Figs. 71, 78).

Key to species of Woolleya

- | | |
|--|-----------------------|
| 1. Tail of female tapering to a point | 2 |
| 1. Tail of female rounded at tip, with spike | 4 |
| 2. Spicules not divided, or trifid | |
| | <i>W. sarcophili</i> |
| 2. Spicules bifid | 3 |
| 3. Female didelphous | <i>W. hydromyos</i> |
| 3. Female monodelphous | <i>W. monodelphi</i> |
| 4. Spicules not divided | <i>W. acinocercus</i> |
| 4. Spicules bifid | 5 |
| 5. Longitudinal crests more or less evenly distributed around body | 6 |
| 5. Longitudinal crests only on ventral surface | 8 |
| 6. Tip of longer branch of each spicule enlarged | <i>W. iota</i> |
| 6. Neither tip of spicules enlarged | 7 |
| 7. Dorsal ray ends in three pairs of branches | <i>W. martini</i> |
| | <i>W. hickmani</i> |
| 7. Dorsal ray ends in two pairs of branches | <i>W. cathiae</i> |
| 8. Narrow lateral alae present | <i>W. sprenti</i> |
| 8. Lateral alae absent | |

Woolleya sprenti n.sp.

FIGS. 79-85; TABLE 4

Host and localities: *Dasyurus viverrinus* from Icena, Tas. (type host and locality); *Antechinus stuartii* from Mt. Tidbinbilla, A.C.T.; *Dasyurus maculatus* from N.S.W.; *Thylacinus cynocephalus* from Tas.

These are relatively long, slender worms, some coiled loosely, some in a tight spiral. The inflated cephalic cuticle, about a quarter the length of the oesophagus, is lightly striated transversely, the cuticle on the rest of the body is more heavily striated and thrown into three longitudinal crests extending most of the body length on the ventral side.

The buccal capsule is large with a dorsal tooth just over half the depth of the capsule. Ventral teeth were not seen. The nerve ring is just behind the mid-oesophagus and the excretory pore near the posterior end of the oesophagus.

The posterior end of the female narrows abruptly just in front of the anus and the tail is digitiform with a rounded tip bearing a terminal spine. The vulva is about five to eight tail-lengths in front of the anus. Two ovejectors

and uteri are present, the posterior much the shorter.

The bursa is symmetrical, its dorsal lobe short but quite distinct. The arrangement of the bursal rays is shown in Figs. 82 and 83. Each spicule bifurcates at about a fifth its length; one branch is slightly longer and stouter than the other, and is curved inwards at the tip. The gubernaculum is long and wide, the central part more heavily chitinised.

The specimens (two females) from *Thylacinus cynocephalus* agree in all particulars with the types. In view of the different host, it is possible that they may belong to a different species, distinguishable only by characters of the male. As the host species is now virtually extinct it is unlikely that a male will be found, unless in some museum. The specimens described here were found in a museum specimen of the host, through the enterprise of Professor J. F. A. Sprent.

This species most closely resembles *N. hydromyos* Thomas in the shape of the spicules and the arrangement of the dorsal ray. The two species differ however in the lengths of spicules and gubernaculum and in the shape of the female tail.

Woolleya martini n.sp.

FIGS. 86-89; TABLE 4

Host and locality: *Antechinomys spenceri* from Sandringham, Qld.

This is a relatively small species, with 10 longitudinal cuticular crests. The cephalic inflation of the cuticle is about twice as long as its diameter, and between a third and a quarter the length of the oesophagus. The cuticle around the mouth forms six distinct lips. The dorsal tooth is about half the length of the buccal capsule. The excretory pore lies at or just behind the base of the oesophagus.

The spicules are bifid in their distal quarter; both branches are slender, one a little more curved and slightly longer than the other. The arrangement of the bursal rays is shown in Fig. 88.

The body of the female narrows just in front of the anus and ends in a digitiform tail, rounded at the tip and bearing a terminal spine. Only two, sub-ventral, crests continue posterior to the vulva.

This species is distinguished from *W. sprenti* chiefly by the number of cuticular crests, and by the origin and shape of the externo-dorsal ray.

¹ The number of terminations of each spicule is not stated in the description of this species.

TABLE 4
 Measurements of *Woolleya* spp. described in this paper. Unless otherwise indicated, measurements are in μm .

Species	<i>Woolleya sprengi</i>		<i>Thylacinus cynocephalus</i>	<i>W. martini</i> <i>Antechinus spencei</i>	<i>W. hickmani</i> <i>Antechinus stuarti</i>	<i>W. monodelphis</i> <i>Antechinus stuarti</i>
	<i>Dasyurus viverrinus</i>	<i>Antechinus stuarti</i>				
Host						
Male:						
Length (mm)	3.6-5.5	2.0-4.3	—	2.2-2.9	2.4-6.4	1.1-1.4
Oesophagus	360	250-280		220-270	330-370	(160+)
Ceph. inflation	100	65-70		70-100	70-90	50-55
Antr. end—nerve ring	190	110		130-190	195	—
—excr. pore	310	200		200-250	350	—
Spicules	350-400	300-320		180-220	260-340	115-125
Gubernaculum	90-100	70-80		55-65	50-55	30-40
Female:						
Length (mm)	5.3-7.8	5.2-5.5	5.5, 5.8	2.9-3.4	5.3-6.2	1.2-1.4
Oesophagus	360-430	280	360, 370	310-320	280-320	150-170
Ceph. inflation	90-100	70	80, 90	75-95	65-80	50-55
Antr. end—nerve ring	180-230	155	175, 185	170-185	—	—
—excr. pore	270-350	240-260	350, 355	270-310	—	—
Tail	100-110	70	75, 80	70-80	50-65	60-90
Postr. end—vulva	710-1000	380-430	800, 800	600-800	340-610	100-140

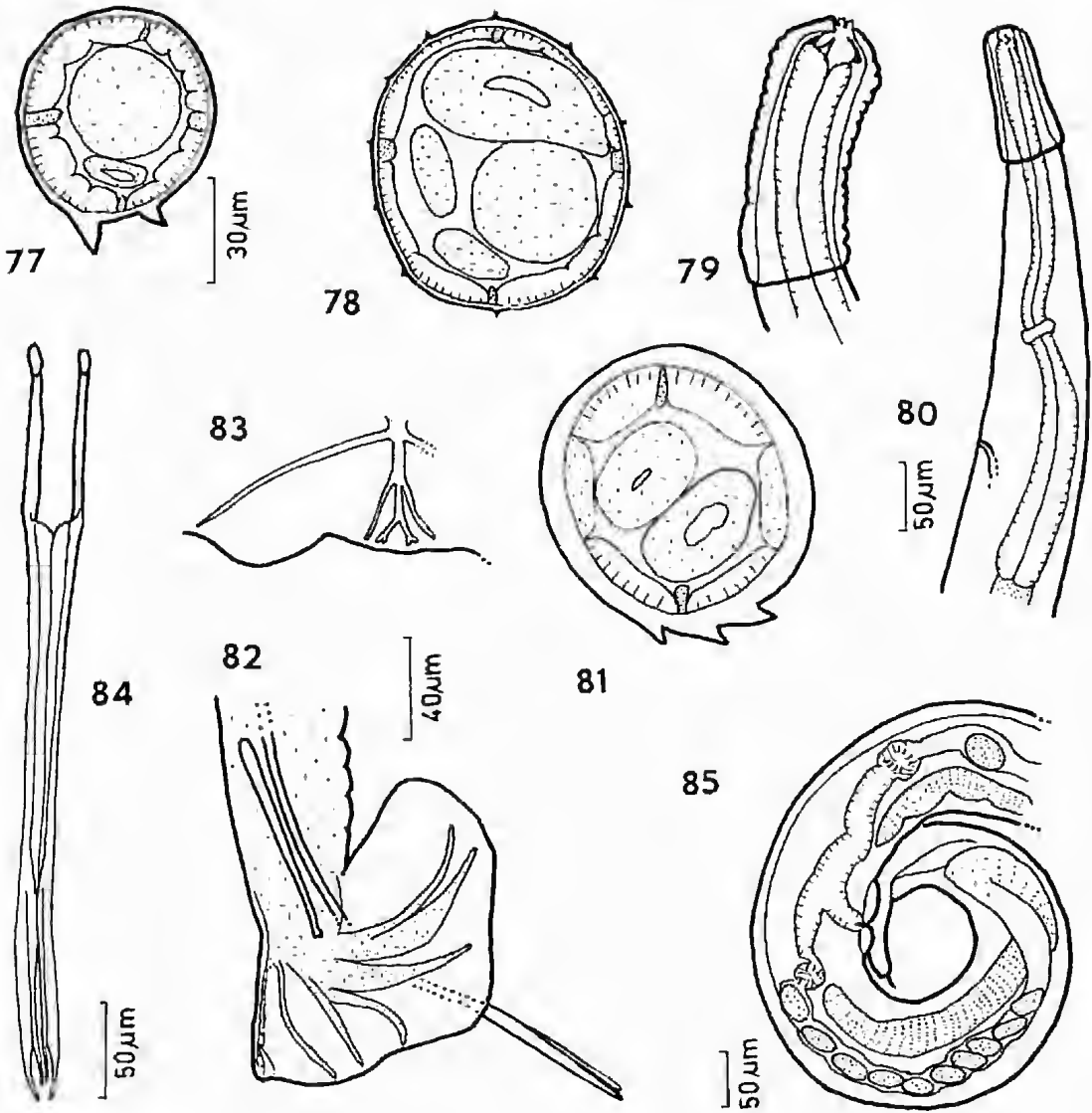


Fig. 77. *Woolleya hydromyos*, transverse section of body.
 Fig. 78. *Woolleya acinocercus*, transverse section of body.
 Figs. 79-85. *Woolleya sprengi*. Fig. 79.—Anterior end. Fig. 80.—Oesophageal region. Fig. 81.—Transverse section of body. Fig. 82.—Posterior end of male. Fig. 83.—Dorsal and one externodorsal rays. Fig. 84.—Spicules. Fig. 85.—Posterior end of female.
 Figs. 77, 79, and 83 to scale beside 77; Figs. 78 and 84 to scale beside 84; Figs. 81 and 82 to scale beside 82.

***Woolleya hickmani* n.sp.**

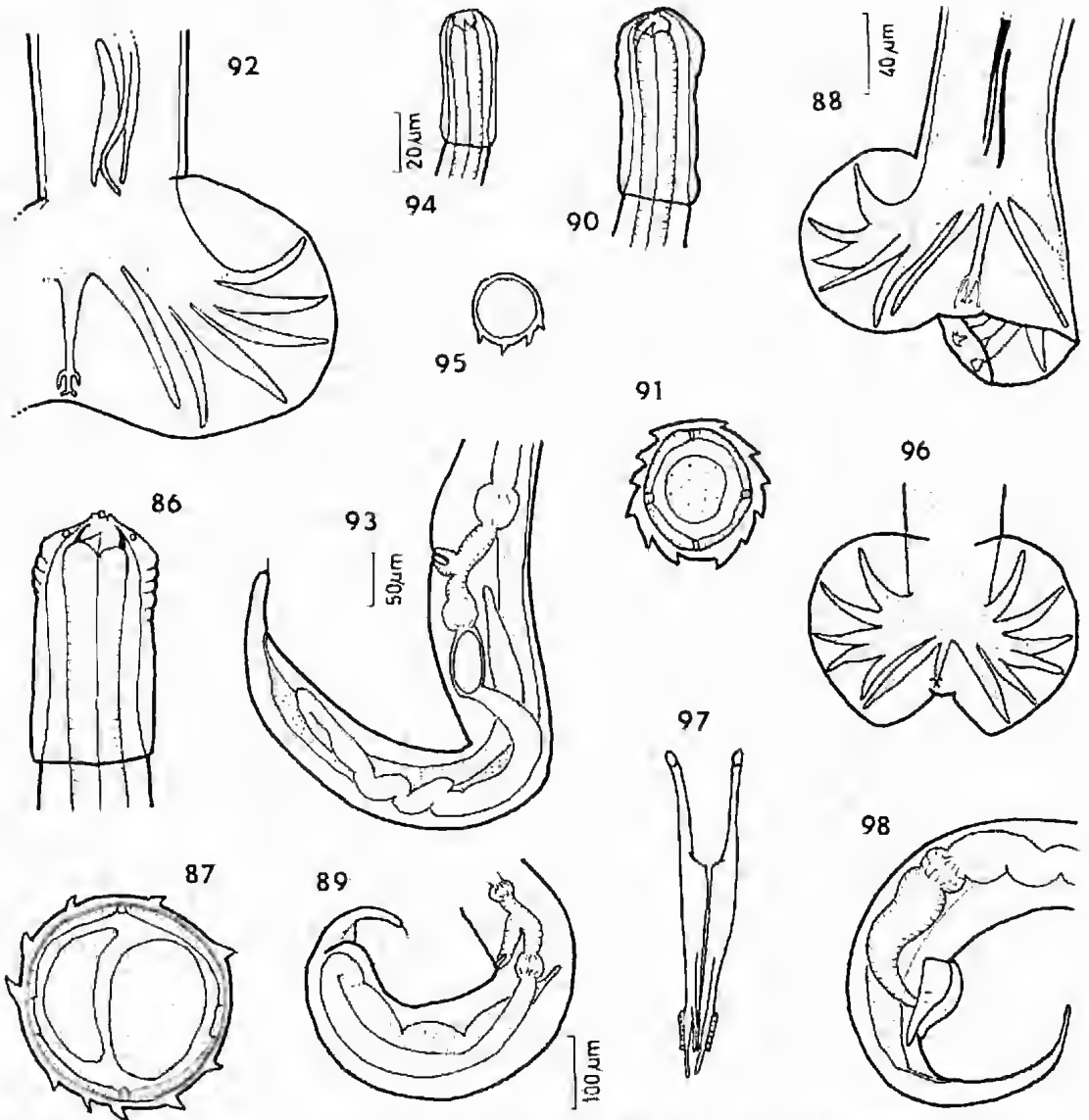
FIGS. 90-93; TABLE 4

Host and locality: *Antechinus stuartii* from Condor Creek and Mt. Tidbinbilla, A.C.T.

These are longish coiled worms. The cuticle is raised into ten or twelve longitudinal crests, extending for most of the body length, and more or less evenly distributed around the

body, the widest gap being on the dorsal side (Fig. 91). The buccal capsule is shallow and the dorsal tooth short.

The bursa is more or less symmetrical, the dorsal lobe not separated from laterals. The arrangement of the rays is shown in Fig. 92. The spicules bifurcate at about 3/4 or 4/5 their length; each branch ends in a blunt point,



Figs. 86-89. *Wolleya martini*. Fig. 86.—Anterior end. Fig. 87.—Transverse section of body. Fig. 88.—Part of bursa. Fig. 89.—Posterior end of female.
 Figs. 90-93. *Wolleya hickmani*. Fig. 90.—Anterior end. Fig. 91.—Transverse section of body behind oesophagus. Fig. 92.—Bursa. Fig. 93.—Posterior end of female.
 Figs. 94-98. *Wolleya monodelphis*. Fig. 94.—Anterior end. Fig. 95.—Transverse section of body. Fig. 96.—Bursa. Fig. 97.—Spicules. Fig. 98.—Posterior end of female.
 Figs. 86, 91, 94, and 97 to scale beside 94; Figs. 87, 88, 90, 92, 96, and 98 to scale beside 88.

the longer one rather more curved at the tip. A thin plate-like gubernaculum is present.

The posterior end of the body of the female is slightly swollen; the tail tapers somewhat and is rounded at the end, with a terminal spike. Two ovejectors are well-developed. Eggs are about $60 \times 30 \mu\text{m}$.

This species differs from *W. martini* in the distribution of the cuticular crests and in the branching of the dorsal ray (see Figs. 88, 92).

Wolleyi monodelphis n.sp.

FIGS. 94-98; TABLE 4

Host and locality: *Antechinus stuartii* from Condor Creek, A.C.T.

This is a very small species; the anterior end of the body ends in a more or less tight spiral; the posterior is curved, and in the female distinctly swollen in the region of the vulva. There are four longitudinal ventral crests, on the anterior two-thirds or more of the body. The

cephalic inflation is about two-thirds the length of the oesophagus. The buccal capsule is large, the dorsal tooth very small. The posterior end of the oesophagus was seen clearly in only one specimen, and the nerve ring and excretory pore were not seen in any.

The arrangement of the bursal rays is shown in Fig. 96. The dorsal ray is unusually stout, and arises separately. The branches of the dorsal ray are very small, and it is possible that the final branch shown in Fig. 96 is divided. The spicules are bifid for about one third of their length, one branch of each being thicker and slightly longer than the other. A slender gubernaculum is present.

The tail of the female is relatively long and tapers to a fine point. The vulva lies about one tail length in front of the anus, between two short and wide sub-ventral crests or flaps. There is only one ovejector and uterus, the anterior. No eggs were seen.

This species differs from all others referred to *Woolleya* in being monodelphous, in the wide externo-dorsal rays, and in the very small

size, and from most of the species in the shape of the tail of the female.

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